PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Environmental Solutions

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DEVELOPMENT OF HYDROCARBON VAPOR IMAGING SYSTEMS FOR PETROLEUM AND NATURAL GAS FUGITIVE EMISSION SENSING

Detecting natural gas leaks

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Background/Problem

New imaging systems are being developed to search for hydrocarbon leaks in refineries and pipelines. Natural gas leaks are invisible and may produce poisonous fumes, and natural gas is highly flammable and explosive. Since most leaks occur in refineries and industrial plants, the original emphasis on leak detection was at the industrial level. However, it was realized that natural gas imaging also provides a viable means of increasing public safety in residential areas.

According to recent statistics a typical refinery spends over $1 million per year for leak detection and repair. Safety statistics indicate that of 800,000 to 900,000 leaks investigated each year, 200 to 300 leaks result in accidents that may cause loss of life, injury and lost time, and damage to facilities. Natural gas leaks in residential areas also may result in loss of life, severe injuries, and significant loss of private structures. Natural gas losses also represent a significant contribution to greenhouse gas emissions. The Environmental Protection Agency (EPA)-mandated testing and pipeline surveys cost American industry over $1.6 billion per year.

Goals were to develop a portable gas imaging camera to detect gas leaks at refineries and a high-power, van-mounted gas imaging camera to detect natural gas leaks in residential areas

Demonstration of the portable LiDAR leak detection unit.

Project Description/Accomplishments

BAGI (Backscatter Absorption Gas Imaging) works by coupling a laser light source with a video camera to allow the operator to see and record visible images of hydrocarbon gases. At the beginning of the project in 1994, the state-of-the-art technology approved for leak detection by EPA was a flame ionization detector “sniffer” (EPA Method 21). This hand-held device could sense leaks only at a single measurement point. BAGI is designed to scan and image natural gas leaks at a standoff distance, which is both cost-effective and safer for individuals operating the system. Laboratory tests showed that the system is capable of “seeing” leaks and that it is sensitive enough to detect the low concentrations required by the natural gas industry in refineries and pipelines.

The first hydrocarbon imager (BAGI) was a pulsed system developed at Sandia between 1996 and 1998. This was a van-mounted camera that could image a gas plume base on wavelength. When a gas capable of absorbing the laser light entered the camera field-of-view, it attenuated a portion of the laser backscatter and appeared as a dark cloud in the video picture.

Development of Hydrocarbon Vapor Imaging Systems for Petroleum and Natural Gas Fugitive Emission Sensing

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The next step in the evolution of the BAGI system was the development of the Light Detecting and Ranging (LiDAR) system. A laser illuminates the scene as it is imaged in infrared. The gases are visualized when they absorb the backscattered radiation. LiDAR is operated by a portable battery pack and can be hand-carried or mounted on a van. The system images a gas plume to provide a visual source of the flow rate.

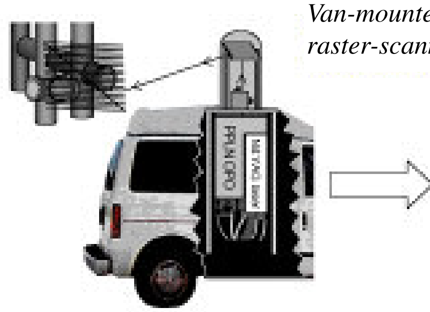
Benefits/Impacts

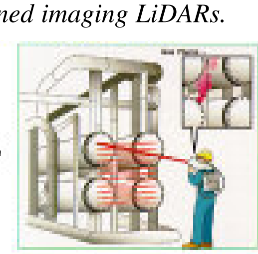
The BAGI and LiDAR systems have the unique ability to remotely generate video images of otherwise invisible plumes of hydrocarbon leaks, and thus greatly simplify the detection and location of gas leak sources. The LiDAR system is a less expensive imaging system than the original BAGI.

A van-mounted LiDAR unit, tested in Atlanta, GA, successfully detected large leaks from underground pipes. The BAGI/LiDAR method was 75% faster, more efficient, and thus more cost-effective to operate than EPA's Method 21. Additional tests in 2003 were conducted in Texas, Illinois, England, Belgium, and the Netherlands.

EPA and the American Petroleum Institute (API) became interested in using the BAGI/LiDAR technology to detect leaks at refineries. Previous regulations required refineries to inspect every joint and flange in the refinery on a periodic basis, using EPA Method 21, and to repair leaks that are greater than a threshold value. These Leak Detection and Repair (LDAR) programs are very labor-intensive and expensive. Under EPA's Common Sense Initiative, EPA issued revised rules in the summer of 2004 which do not specify a technology and will permit the use of LiDAR. Industry has expressed interest in implementing LiDAR.

In order to detect natural gas leaks in residential areas at the low leak concentration required, a more powerful system that could overcome the problems created by varied backgrounds was required. LiDAR, the second-generation BAGI has a 130ft scan width and operates at a 100 times greater survey distance. Because the BAGI/LiDAR system requires fewer people to operate, it is expected to reduce the cost of leak detection by 50%. Sandia currently is interfacing with companies to manufacture commercial versions of the the device.





Van-mounted and operator-portable raster-scanned imaging LiDARs.

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TOTAL ESTIMATED COST

$1.66 million

COST SHARING

$1.66 million

WEBSITE

www.netl.doe.gov